Hand Injuries in Rock Climbing: Reaching the Right Treatment

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In Brief: Rock climbers' grip techniques may result in a variety of hand injuries. Minor injuries such as soft-tissue damage, flexor tendon strain, tendinitis or tenosynovitis, joint contractures, and carpal tunnel syndrome may be treated by a primary care physician. Patients who have pulley ruptures should be referred if there is any uncertainty about the diagnosis. Because of controversies regarding surgical management, primary care physicians should refer patients who have a complete ligament tear. Referral is also recommended for such serious injuries as locked digits, flexor tendon avulsions or ruptures, and severe joint contractures.

The exhilarating sport of rock climbing has grown in popularity for both recreation and competition. Rock climbers rely predominantly on digital and upper-extremity strength and tactile ability to ascend shallow ledges and rock faces, using any of four grip techniques depending on the terrain. All four of the grip techniques transmit extremely high forces through the tissues of the digits, hand, and forearm, resulting in a variety of possible acute and chronic injuries (1-10). Indeed, the hand is regarded by some as the most common site of injury in mountaineers and rock climbers (1). These injuries may at times seem minor and inconsequential, but because they can seriously compromise a climber's ability and safety, proper recognition, treatment, rehabilitation, and prevention are essential.

Hand Anatomy

The muscles that produce wrist and digital flexion originate from the medial elbow, proximal forearm and hand. The tendons insert on the middle and distal phalanges. The flexor digitorum superficialis (FDS) muscles are responsible for flexion of the proximal interphalangeal (PIP) joints, and the flexor digitorum profundus (FDP) muscles are responsible for flexion of the distal interphalangeal joints. The FDS is the largest superficial muscle in the forearm and inserts on the palmar surface of the middle phalanges. The FDP originates from the ulna and the interosseous membrane and inserts on the palmar aspect of the distal phalanges.

Each finger has a single FDS and FDP tendon. Together with the median nerve, these tendons pass from the forearm to the hand through the carpal tunnel. Within the tunnel, the tendons are enclosed in bursal tissue and tenosynovium.
At the level of the metacarpal heads, the tendons enter into a double-walled hollow tube sealed at both ends, known as the flexor tendon sheath (figure 1: not shown). This sheath is filled with synovial fluid, which provides low-friction gliding and is a source of nutrition for the flexor tendons. The sheath is supported by a series of retinacular thickenings which function as pulleys. These pulleys prevent tendon bowstringing with flexion and are referred to as annular or cruciform depending on their configuration. The second (A2) and fourth (A4) annular pulleys, located at the proximal and middle phalanges respectively, are the most important for preventing tendon bowstringing during active flexion.

**Grip Techniques**

With each of the four basic grips, the climber relies on tactile feedback from the index and long fingers and strength from the ring finger.

**Open grip.** The open grip (figure 2) is used when grasping wide or large handholds. This grip frequently turns into a cling grip as the climber pulls himself or herself upward.

**Cling grip.** In the cling grip (also known as the "crimp"), the distal interphalangeal (DIP) joint hyperextends as force is exerted downward and the climber pulls his or her body upward (figure 3). This is a commonly used grip technique and is regarded as the most painful. It places significant compression and shear on the finger tips and strain on the digital flexor tendons, adjacent sheath, and pulleys. Climbers practice the cling grip by doing one- or two-finger pull-ups on doorjambs or training boards. In moderation, this exercise can strengthen the fingers and prevent injury, but it can also lead to injuries if done excessively.

**Pocket grip.** This grip involves the placement of one or two fingers into small holes (figure 4). It is another particularly demanding grip because during ascension the flexor tendons support most, if not all, of the climber's body weight.

**Pinch grip.** This grip is used to grasp a projection of rock between the thumb and fingers.

**Types of Climbing**

Most rock-climbing situations fit one of the following classifications:

**Bouldering.** This term refers to climbing over large rocks, usually to develop strength and practice difficult maneuvers. This type of
climbing results in fewer hand injuries than other types of rock climbing.

**Face climbing.** This refers to the use of small edges, pockets, and knobs of rock for footholds and handholds (2).

**Crack climbing.** Here, the climber ascends flat rock faces using the fingers, hands, and feet as wedges (figure 5). When a climber pushes and twists his or her fingers until they are wedged into a crack, torque forces on the finger joints can be very high. This type of climbing is associated with joint dislocations and digital avulsion amputations following a sudden slip or fall (2).

### Types of Hand Injuries

In general, the incidence of hand and wrist injuries can be closely correlated with the duration and frequency of climbing and with the climbing techniques used. A quick way to gauge the amount of climbing a person does is to inspect the hands for abrasions and hypertrophic scarring. With greater awareness of the causes and frequency of hand injuries, climbers have been better able to focus on prevention by adjusting their training schedules and emphasizing strength, conditioning, and flexibility training (3).

Most climbers' hand injuries are relatively minor and can be treated with rest, anti-inflammatory medication, and splinting and taping. Certain injuries, however, require referral and surgical intervention, and others, if neglected or not recognized, may have serious functional consequences. Among these more serious injuries are flexor tendon strains, pulley strains, and ruptures.

### Soft-Tissue Injuries

Among the relatively minor hand injuries are soft-tissue injuries, including fingertip injuries; abrasions on the dorsum of the hand and fingers, called "gobies"; and hypertrophic scarring.

Fingertip injuries are the most common hand injuries in rock climbers (2), but climbers rarely seek evaluation or treatment for them. Fingertip injuries include maceration and splitting of the skin on the finger pads due to prolonged pressure and abrasion. Both mechanical factors and ischemic mechanisms cause epidermal breakdown (4).

Hypertrophic scar tissue forms on the dorsal surface of the hand in response to the repetitive abrasion and wear that usually occurs with crack climbing.

Treatment of soft-tissue injuries includes rest, appropriate local wound care, and preventive measures such as the use of thin rubber pads or sleeves for protection when climbing or training. Gloves are not advised because they interfere with critical tactile feedback and do not allow for a secure handhold (2).

### Flexor Tendon Injuries

Several studies describe a spectrum of rock-climbing injuries involving the digital flexor tendons (2,3,5-7). These injuries appear to have a common pathogenesis and similar symptoms. Injuries to the flexor tendons include tendinitis or tenosynovitis, strains, and rupture or avulsion. The flexor tendons are particularly susceptible to injury during the cling and pocket
grips (2,6). These maneuvers place excessive stress on the tendons and surrounding structures. With the cling grip, the majority of the stress of weight-bearing is transferred from the hyperextended DIP joint to the flexed proximal interphalangeal (PIP) joint along the flexor digitorum superficialis (FDS) tendon. Because the cling grip is used most often, the FDS tendon is the one most likely to be injured.

**Flexor tendinitis and tenosynovitis.** In flexor tendinitis and tenosynovitis, an inflammatory response occurs because of repetitive stress. The patient has pain and swelling along the palmar surface of the digit, which may extend into the palm or forearm. While the patient’s passive flexion is normal, active flexion is usually limited.

A patient who has flexor tendinitis or tenosynovitis should rest, take anti-inflammatory medication, and do range-of-motion exercises. Corticosteroid injection is rarely used, but may be indicated in patients who have chronic tendinitis or tenosynovitis and for whom all other treatment modalities have failed. Injection should be performed carefully as intratendinous injections may result in tendon rupture.

**Flexor tendon strain.** This injury is characterized by acute onset of pain at the FDS tendon insertion during a difficult cling grip. It is often referred to as "climber's finger." (3) If a patient presents acutely, tenderness at the FDS tendon insertion site is noted and pain may be accentuated with resisted PIP joint flexion.

A patient who has flexor tendon strain should rest, take an anti-inflammatory medication for control of digital swelling, and do range-of-motion exercises. When pain has subsided and range of motion has been restored, a progressive strengthening program can be started, followed by a gradual return to climbing. Digital taping may be used as a preventive measure. Many climbers circumferentially wrap the digits to help prevent flexor tendon and sheath injuries (1,2,5).

**Tendon nodules.** Patients who have a history of repetitive flexor tendon strains may have a palpable nodule in the digit or distal palm. The nodule is located within the tendon itself and may cause locking or triggering of the digit. During digital extension, the nodule catches on the first annular (A1) pulley, resulting in a triggering sensation. If the nodule becomes large enough, eventually it may not pass beneath the pulley, resulting in a "locked" finger that cannot be extended either actively or passively. On physical examination, if a nodule is present, it may be palpated within the flexor tendon. Triggering may be reproduced by applying pressure over the A1 pulley during flexion and extension of the involved digit. Treatment includes injection of a corticosteroid and lidocaine hydrochloride preparation into the flexor tendon sheath. If triggering continues even after two injections given a minimum of 6 weeks apart, or if a patient's digit is locked, surgical release of the A1 pulley is indicated.

**Flexor tendon avulsion and rupture.** An FDS tendon rupture may occur with the cling grip, an FDP tendon rupture with the pocket grip. Patients who have these ruptures complain of the acute onset of pain during a grip. Findings include tenderness at the FDS or FDP tendon insertion, digital swelling, and an absence of active flexion of the PIP joint (with an FDS tendon rupture) or DIP joint (with an FDP tendon rupture). Frequently the end of the tendon retracts, and consequently tenderness and swelling may also be noted more proximally in the digit or even in the palm.

Flexor tendon rupture requires surgical reattachment or repair when recognized acutely. Patients who present more than 3 weeks after injury may be treated with a variety of surgical and nonsurgical methods. Referral to a surgeon familiar with contemporary methods of treatment for flexor tendon injuries is appropriate for these patients.
**Second Annular Pulley Rupture**

Rupture of the A2 pulley is a relatively common injury and in one study (5) has been reported in up to 40% of professional climbers. Rupture occurs as a result of the excessive stress on the A2 pulley during a cling grip. The long and ring fingers are most commonly involved. Pulley rupture can occur acutely or develop insidiously.

A patient who has acute pulley rupture complains of acute pain in the volar proximal phalanx region. The area is tender to palpation, and visible and palpable bowstringing of the flexor tendons is usually noted during active resisted finger flexion (figure 6: not shown). The diagnosis may be difficult, and a limited magnetic resonance imaging scan or computed tomography scan may be necessary to help determine the integrity of the pulley and flexor tendons (6,8).

Minor A2 pulley injuries or partial tears with no evidence of bowstringing can be treated with either firm circumferential taping overlying the pulley or with a ring splint, worn full-time for 2 to 3 months to permit healing. Patients should also take time off from climbing.

The management of complete tears with tendon bowstringing is controversial. Surgical options include pulley repair or reconstruction (6,8,9). If there is any uncertainty regarding the diagnosis of A2 pulley rupture or the management of this type of injury, referral is recommended.

**Joint Contracture**

A fixed flexion deformity of the PIP joint is a common finding in rock climbers (1) The deformity is frequently bilateral and most commonly involves the ring finger (1). The contracture is usually mild and is thought to be the result of recurrent joint effusions and synovitis.

Treatment includes rest, stretching exercises, anti-inflammatory medication, postexercise icing, and a dynamic PIP joint extension splint. Severe fixed contractures that compromise hand function may require surgical correction. Consultation with a hand therapist or surgeon is appropriate for such a patient.

**Ligament Injuries**

Sprain, acute rupture, and chronic attenuation of the collateral ligaments of the finger (PIP) joint and thumb metacarpophalangeal (MCP) joints have been reported in rock climbers (2). PIP joint collateral ligament injuries predominantly involve the long finger and occur during a maneuver known as "dynoing," (5) meaning rapid ascension of a rock face. As the climber ascends rapidly past a pocket in the rock in which his or her fingers are placed, a finger can become trapped and bent, stretching the ligament awkwardly. Sprains of the ulnar collateral ligament of the thumb MCP joint are associated with the pinch grip (1).

Examination of patients who have ligament injuries reveals mild to moderate PIP joint swelling, tenderness, and pain with motion. To assess the integrity of the collateral ligaments, palpate them gently and then stress the ligaments with the joint first flexed and then extended. The joint may need to be anaesthetized. Complete rupture is suggested when the joint can be widely deviated during stress testing.

Treatment of a patient who has a PIP joint sprain with intact collateral ligaments includes rest, icing, edema control, continued range-of-motion exercises, and "buddy taping" to the adjacent
finger on the side of the injury. Persistent pain and swelling are common and may take months to resolve, but patients are still able to climb. Patients who have partial collateral ligament tears should be treated with the same protocol.

The management of complete tears of the PIP collateral ligament is controversial, and there are proponents for both surgical and nonsurgical treatment methods. Partial tears of the thumb MCP joint collateral ligaments are treated in a custom-fabricated, hand-based Orthoplast thumb spica splint (Johnson & Johnson Orthopaedics, Raynham, MA) for 4 to 6 weeks. Management of complete tears of the thumb MCP collateral ligaments is controversial and confusing, with many different recommendations. If such an injury is suspected or detected, the patient should be referred appropriately. Chronic injuries with joint instability that impairs hand function usually require either reconstruction or joint arthrodesis, depending on the duration of symptoms, patient demands, and the status of the articular surfaces of the joint.

Carpal Tunnel Syndrome

Compression of the median nerve within the carpal tunnel can be the result of a rock climber's repetitive, sustained flexion of the wrist. (See "Acute Carpal Tunnel Syndrome: Wrist Stress During a Major Climb," July 1993, page 102.) Associated transient tenosynovitis of the digital flexor tendons is a common finding. The patient complains of volar wrist and forearm pain and paresthesias in the radial 3 1/2 digits. Night symptoms are common. Evaluation includes assessment of static two-point discrimination and motor strength and provocative measures such as Phalen's maneuver and testing for Tinel's sign. Swelling in the region of the distal forearm may also be noted. Unless the symptoms are longstanding, motor weakness and atrophy of the thenar musculature are not seen.

Treatment involves avoiding climbing, and splinting the patient's wrist in a neutral position. Anti-inflammatory medication may be used in patients who have associated tenosynovitis. Injection of the carpal tunnel should be reserved for those patients who have complied with rest and splinting but continue to have symptoms for longer than 3 months. The majority of climbers respond to this conservative treatment approach, and surgery is rarely indicated.

Prevention Pointers

Physicians can give patients pointers on ways to prevent injuries with skin protection, exercise, and taping. Thin rubber pads or sleeves applied to the finger or tape wrapped around the finger will help prevent skin and fingertip injuries. Participation in an exercise program that includes stretching and range-of-motion exercises for the wrist and fingers will help prevent flexor tendon and pulley injuries. Strengthening exercises should also be included and are best done by progressively increasing the duration and intensity of exercise against resistance. Circumferential finger taping while climbing may also help reduce the risk of pulley injuries.

References


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